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# NEW KARYOTYPES OF SHREWS (MAMMALIA: SORICIDAE) FROM CAMEROON AND SOMALIA

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## ABSTRACT

Chromosomal data are presented for 11 species of African shrews collected during field studies in Cameroon and Somalia. The karyotypes of *Sylvisorex johnstoni, S. isabellae, S. ollula, Crocidura attila, C. batesi, C. greenwoodi, C. parvipes, C. picea,* and *C. yankariensis* are reported for the first time. The karyotype of *Sylvisorex johnstoni* (2n = 30, FN = 38) represents one of the lowest and that of *Crocidura yankariensis* (2n = 68, FN = 122) the highest diploid numbers so far reported for an African shrew. The rare *Crocidura picea* has been rediscovered in the Cameroon highlands, from whence the species was known only by the holotype since 1940.

KEY WORDS: *Sylvisorex, Crocidura,* shrews, Africa, karyotypes

## INTRODUCTION

African shrews present a variety of problems taxonomically, with the diversity of species being of principal concern. Recent checklists of the African species in the genera *Sylvisorex* and *Crocidura* list ten and 104 species, respectively (Hutterer, 1993). In addition, most species are difficult to obtain in the field and maintain in a vivarium. Although comparisons of species using cytotaxonomic and biochemical techniques are desirable, they are generally unavailable. Karyotypic comparisons using differential staining methods are needed but have been difficult to obtain. For most species, even standard karyotypes are unknown.

Although standard karyotypes are of limited value in assessing chromosomal evolution and phylogenetic relationships within genera, these data may still be useful for clarifying some taxonomic issues (Baker et al., 1987), especially in detecting potential cryptic or sibling species, confirming species status, or determining general karyotypic trends.

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Table 1.—*Summary of karyotypic data for shrews occurring on the African continent, arranged by increasing diploid number. The nomenclature of the species as given in the original reports has been critically revised (Reumer and Meylan, 1986; Hutterer, 1993).*

| Species | 2n | FN | FNa | Reference—country |
|---|---|---|---|---|
| *Crocidura* | | | | |
| *canariensis* | 36 | 56 | 52 | 4[1]—Canary Is. |
| *luna* | 36 | 56 | 52 | 6—Burundi |
| *obscurior* | 36 | 56 | — | 6—Côte d'Ivoire |
| *lusitania* | 38 | 74 | | 6—Burkina |
| *bottegi* | 40 | 60 | | 10—Côte d'Ivoire |
| *russula* | 42 | 60 | 56 | 4—Morocco |
| *osorio* | 42 | 62 | 58 | 5—Canary Is. |
| *nanilla* | 42 | 74 | | 6—Côte d'Ivoire |
| *ebriensis* | 44 | 66 | | 10—Côte d'Ivoire |
| *ebriensis* | 44 | 72 | | 6—Côte d'Ivoire |
| *crossei* | 44, 45 | 72, 73 | 68 | 6, 12—Côte d'Ivoire |
| *grandiceps* | 46 | 68 | 64 | 12—Côte d'Ivoire |
| *nigrofusca* | 48 | 78 | | 6—Burundi |
| *o. olivieri* | 50 | 66 | 62 | 1—Egypt |
| *o. spurrelli* | 50 | 66 | 62 | 10—Côte d'Ivoire |
| *o. kivu* | 50 | 66 | 62 | 9—Zaire |
| *o. manni* | 50 | 66 | 62 | 12—Mali, Cameroon, Nigeria |
| *o. odorata* | 50 | 66 | 62 | 6, 12—Burkina Faso |
| *o. bueae* | 50 | 66 | 62 | This study—Cameroon |
| *o. cinereoaenea* | 50 | 66 | | 15—Ethiopia |
| *viaria* | 50 | 66 | 62 | 12—Morocco |
| *viaria* | 50 | 66 | 62 | 6—Burkina Faso |
| *hirta* | 50 | 66 | 62 | 8—Tanzania |
| *greenwoodi* | 50 | 66 | — | This study—Somalia |
| *attila* | 50 | 66 | 62 | This study—Cameroon |
| *flavescens* | 50 | 74 | 70 | 7—South Africa |
| *batesi* | 50 | 76 | — | This study—Cameroon |
| *nigeriae* | 50 | 76 | 72 | 12—Nigeria |

The standard karyotypes of 11 species of shrews, collected during fieldwork in Cameroon and Somalia, are presented and compared to other geographic samples and species. Published karyotypic data for an additional 38 species and subspecies are presented for comparison (Table 1).

## Materials and Methods

All karyotypes were obtained from bone marrow preparations made in the field by the in vivo incubation method described by Robbins and Baker (1978) during field trips in 1978 (Cameroon) and 1982 (Somalia). Determinations of diploid numbers were based on counts of at least ten metaphases. Nomenclature of chromosome morphology used is that of Levan et al. (1964). All specimens examined were prepared as standard museum voucher specimens and are housed at the Carnegie Museum of Natural History (CM).

## Specimens Examined

*Sylvisorex johnstoni.*—**Cameroon**: 4 km S, 2 km E Eseka (3°36′N, 10°48′E) (CM 58078 ♂, CM 58080 ♀).

*Sylvisorex isabellae.*—**Cameroon**: 11 km S, 1 km E Bamenda, 1900 m (5°51′N, 10°10′E) (CM 58081 ♀, CM 58085 ♀).

Table 1.—*Continued*

| Species | 2n | FN | FNa | Reference—country |
|---|---|---|---|---|
| *Crocidura* | | | | |
| *wimmeri* | 50 | 84 | 80 | 12—Côte d'Ivoire |
| *theresae* | 50 | 82, 84 | | 10—Côte d'Ivoire |
| *?thalia* | 50 | | | 13—Ethiopia |
| *parvipes* | 52 | 66 | — | This study—Cameroon |
| *lamottei* | 52 | 68 | 64 | 10—Côte d'Ivoire |
| *poensis* | 52, 53 | 70, 72 | 66 | 10, 12—Côte d'Ivoire |
| *hildegardeae* | 52 | 76 | | 6—Burundi |
| *virgata* | 52 | 86 | 82 | 12—Nigeria |
| *fuscomurina* | 56 | 86 | 82 | 6—Burundi |
| *picea* | 58 | 66 | | This study—Cameroon |
| *"bicolor"* | 60 | — | — | 13—Ethiopia |
| *yankariensis* | 68 | 122 | 118 | This study—Somalia |
| *Myosorex* | | | | |
| sp. | 24 | — | 36 | 14—South Africa |
| *cafer* | 38 | — | 58, 60 | 2, 14—South Africa |
| *sclateri* | 38 | — | — | 2, 14—South Africa |
| *tenuis* | 40 | — | — | 2, 14—South Africa |
| *varius* | 42 | — | 74 | 2, 14—South Africa |
| *Suncus* | | | | |
| *murinus* | 40 | — | — | 3—Djibouti |
| *Sylvisorex* | | | | |
| *johnstoni* | 30 | 38 | 36 | This study—Cameroon |
| *isabellae* | 36 | 40 | — | This study—Cameroon |
| *morio* | 38 | — | — | This study—Cameroon |
| *ollula* | 38 | 64 | 62 | This study—Cameroon |
| *megalura* | 48 | 96 | — | 11—Côte d'Ivoire |
| *lunaris* | 58 | 80 | — | 6—Burundi |

[1] Reference codes:
1—De Hondt, 1974.
2—Dippenaar et al., 1983.
3—Hutterer and Tranier, 1990.
4—Hutterer et al., 1987.
5—Hutterer et al., 1992.
6—Maddalena, 1990*a*; Maddalena and Ruedi, 1994.
7—Maddalena et al., 1987.
8—Maddalena et al., 1989.
9—Meylan, 1967.
10—Meylan, 1971.
11—Meylan, 1975.
12—Meylan and Vogel, 1982.
13—Orlov et al., 1989.
14—Wolhuter, *in* Smithers, 1983.
15—Baskevich et al., 1995.

*Sylvisorex morio*.—**Cameroon**: Buea, Upper Farm, Mount Cameroon (4°10′N, 9°14′E) (CM 58098 ♀).

*Sylvisorex ollula*.—**Cameroon**: Buea, Upper Farm, Mount Cameroon (4°10′N, 9°14′E) (CM 58119 ♂); 30 km N, 40 km E Obala (4°22′N, 11°58′N) (CM 58120 ♂).

*Crocidura attila*.—**Cameroon**: 11 km S, 1 km E Bamenda, 1900 m (5°51′N, 10°10′E) (CM 58051 ♂).

*Crocidura batesi*.—**Cameroon**: Yaounde, Mont Febe, 1900 m (3°52′N, 11°31′E) (CM 58072 ♀).

*Crocidura greenwoodi*.—**Somalia**: Libsoma Farm, 6 km S, 17 km W Afgoi (2°05′N, 44°58′E) (CM 85103 ♂, CM 85105 ♀).

*Crocidura olivieri*.—**Cameroon**: Buea, Upper Farm, Mount Cameroon (4°10′N, 9°14′E) (CM 58017 ♀); Yaounde (3°52′N, 11°31′E) (CM 58039 ♂).

*Crocidura parvipes*.—**Cameroon**: 1 km S, 1 km W Ngaoundere (7°18′N, 13°34′E) (CM 58046 ♀, CM 58049 ♀).

*Crocidura picea*.—**Cameroon**: 11 km S, 1 km E Bamenda, 1900 m (5°51′N, 10°10′E) (CM 58050 ♀, CM 58061 ♀, CM 58065 ♀).

*Crocidura yankariensis*.—**Somalia**: Libsoma Farm, 6 km S, 17 km W Afgoi (2°05′N, 44°58′E) (CM 85086 ♂, CM 85088 ♀); SNAI Sugar Plantation, 1½ km S, ½ km E Giohar (2°46′N, 45°31′E) (CM 85091 ♀).

## RESULTS

Representative karyotypes for the species examined in this study are presented in Figures 1–4. A summary of these data and that of the published literature on the chromosomal morphology for species of African shrews is presented in Table 1.

A brief description of the karyotypes for each species reported from this study follows.

### *Sylvisorex johnstoni* (Dobson, 1888)
### (2n = 30; FN = 38; Fig. 1A)

The karyotypes of the female and male specimens of this species examined possess four pairs of submetacentric and ten pairs of acrocentric autosomes, grading from a very large pair to 13 pairs of medium-sized chromosomes. The X chromosome is a medium-sized acrocentric whereas the Y is a tiny chromosome.

### *Sylvisorex isabellae* Heim de Balsac, 1968
### (2n = 36; FN = 50; Fig. 1C)

The karyotype of the two females of this species that were examined each consisted of six pairs of large- to medium-sized metacentric and submetacentric and 12 pairs of acrocentric chromosomes. Since only females were analyzed, it is not possible to identify the sex chromosomes for this species.

### *Sylvisorex morio* (Gray, 1862)

Although specimens of this species from Mount Cameroon were karyotyped, the quality of the preparations was too poor to obtain publishable figures. However, spreads examined from a single specimen indicate that the diploid number is probably 38.

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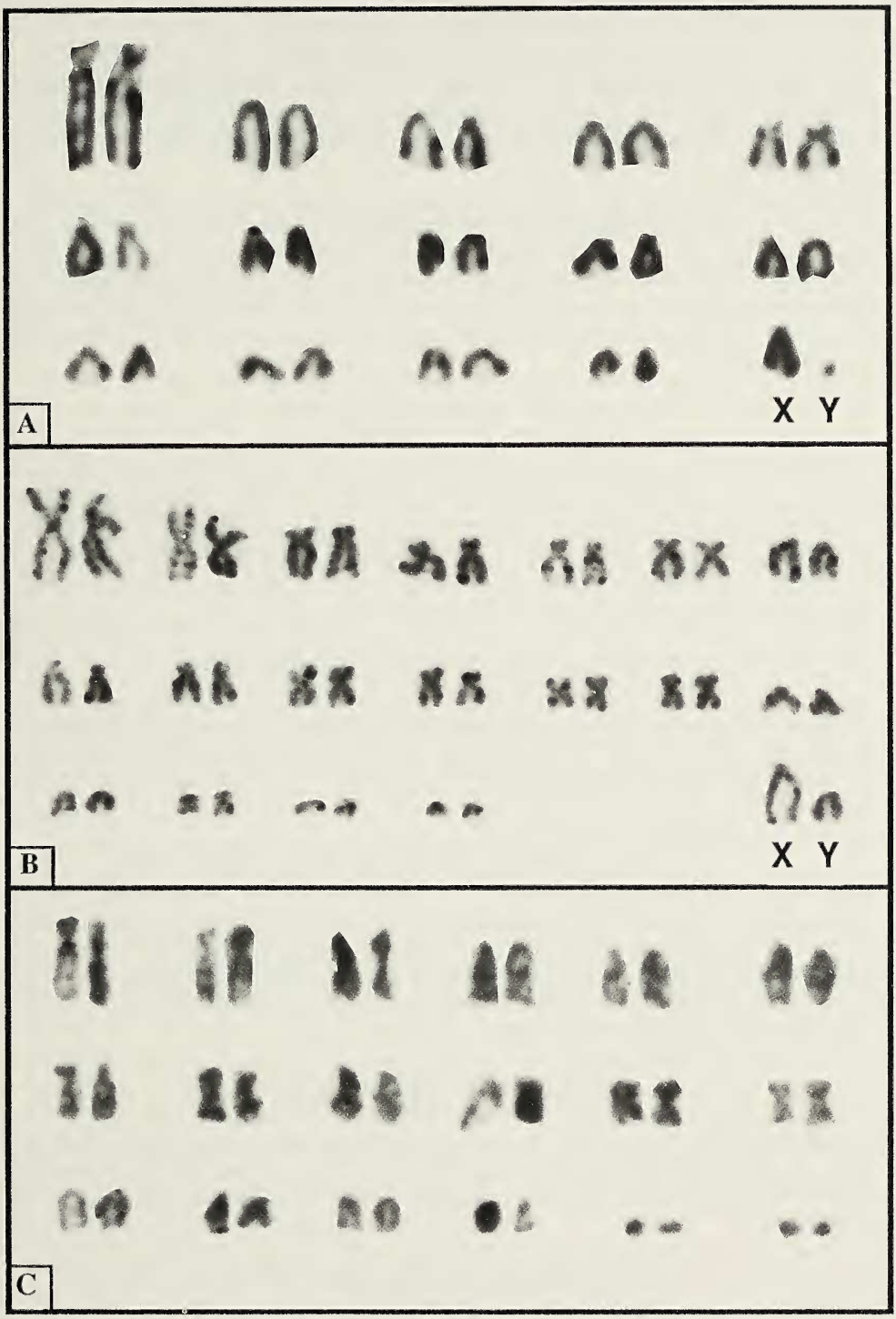
Fig. 1.—Standard karyotype of: A, *Sylvisorex johnstoni* ♂ (CM 58078), 2n = 30, FN = 38 (FN includes sex chromosomes); B, *Sylvisorex ollula* ♂ (CM 58120), 2n = 38, FN = 64; C, *Sylvisorex isabellae* ♀ (CM 58081), 2n = 36, FN = 50.


A
X Y
B
X Y
C

*Sylvisorex ollula* Thomas, 1913
(2n = 38; FN = 64; Fig. 1B)

The two males of this species examined indicate that the karyotype consists of 13 pairs of a graded set of large- to medium-sized metacentric and submetacentric and five pairs of small acrocentric autosomes. The X and Y chromosomes are both acrocentric.

*Crocidura attila* Dollman, 1915
(2n = 50; FN = 66; Fig. 2B)

The single male that was karyotyped possessed seven pairs of metacentric and submetacentric and 17 pairs of acrocentric autosomes ranging from large to small in size. The X chromosome is a medium-sized metacentric and the "Y" is a small acrocentric one.

*Crocidura batesi* Dollman, 1915
(2n = 50; FN = 76; Fig. 2A)

The results of an analysis of the karyotype of the single female available of this species reveals that the karyotype consists of 13 pairs of metacentric and submetacentric and 12 pairs of acrocentric chromosomes. Only a single female was available, therefore the X and Y chromosomes could not be distinguished at this time. By analogy with other species of *Crocidura,* however, the X chromosome should be a large metacentric one.

*Crocidura greenwoodi* Heim de Balsac, 1966
(2n = 50; FN = 66; Fig. 4B)

The karyotype of this shrew is characterized by seven pairs of large metacentric and submetacentric and 17 pairs of large- to small-sized acrocentric autosomes. The X chromosome is a large metacentric and the Y is a small acrocentric chromosome.

*Crocidura olivieri bueae* Heim de Balsac and Barloy, 1966
(2n = 50; FN = 66; Fig. 2C)

Of the individuals of this species that were karyotyped, a male and a female had spreads suitable for analysis. The karyotype consists of seven pairs of medium-sized metacentric and submetacentric and 17 pairs of medium- to small-sized acrocentric autosomes. The X chromosome is a large metacentric and the Y is a small acrocentric chromosome.

*Crocidura parvipes* Osgood, 1910
(2n = 52; FN = 66; Fig. 3B)

Suitable spreads were available only from two females. These had a chromosomal complement consisting of seven pairs of large metacentric and submetacentric and 19 pairs of acrocentric autosomes. The sex chromosomes could not be distinguished.

*Crocidura picea* Sanderson, 1940
(2n = 58; FN = 66; Fig. 3A)

Three females of this rare species, previously known only by the holotype (Sanderson, 1940), were available for study. From these, a karyotype consisting

of four pairs of large metacentric and 25 pairs of large- to small-sized acrocentric chromosomes was developed. The sex chromosomes could not be distinguished but the X is probably one of the large metacentric chromosomes.

*Crocidura yankariensis* Hutterer and Jenkins, 1980
(2n = 68; FN = 122; Fig. 4A)

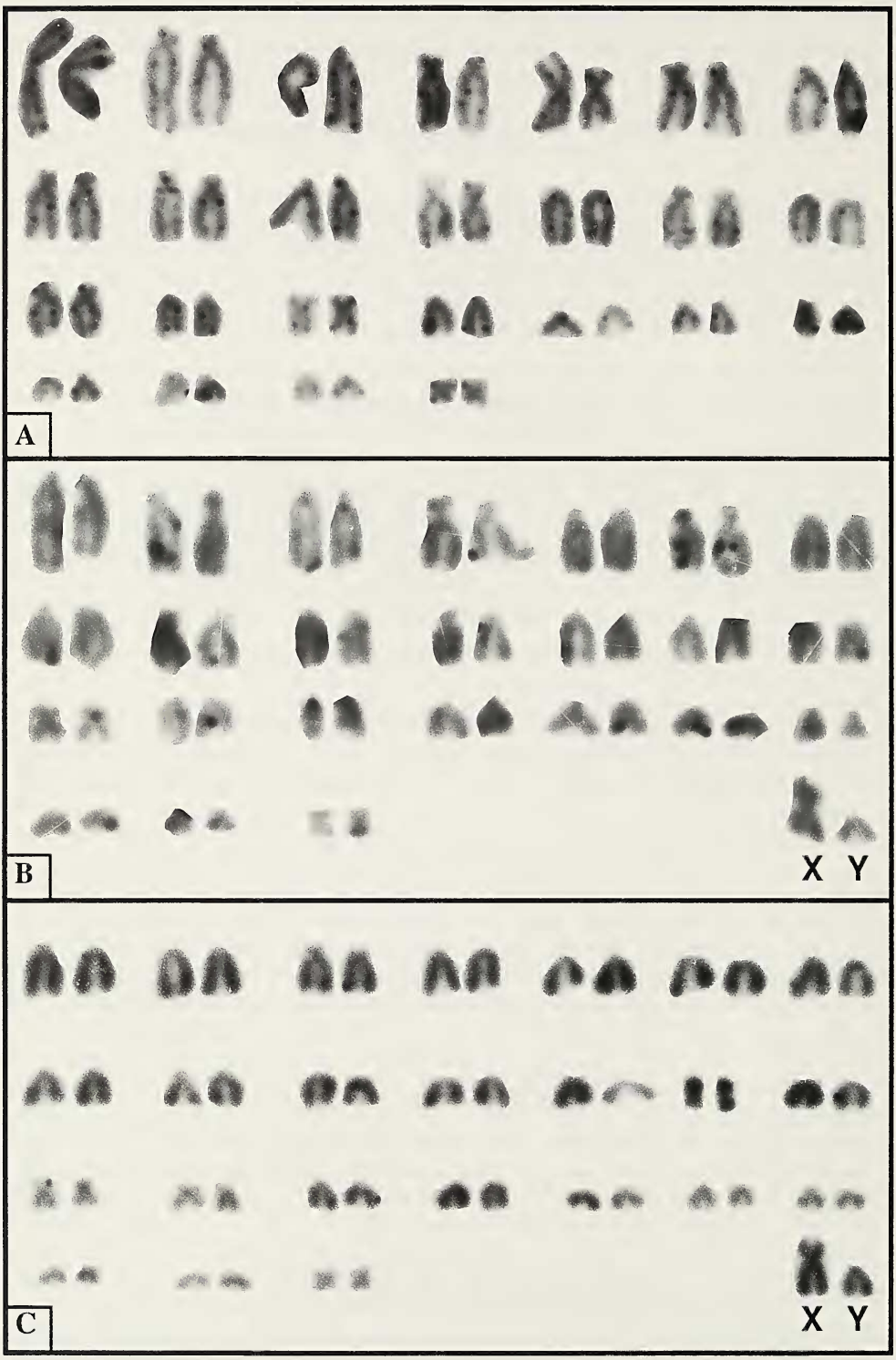
Spreads from a single female and male possessed 26 pairs of large- to small-sized metacentric and submetacentric chromosomes and only seven pairs of small acrocentric chromosomes in the autosomal complement. The X chromosome is a very large metacentric and the Y is an acrocentric.

## DISCUSSION

Of the ten currently recognized species in the genus *Sylvisorex,* karyotypes of only two species have been reported previously: *S. megalura* from the Côte d'Ivoire (2n = 48, FN = 96) (Meylan, 1975) and *S. lunaris* from Burundi (2n = 58, FN = 80) (Maddalena, 1990*a*; Table 1). The karyotypes of the three additional species in the genus that are reported here are characterized by very low diploid and fundamental numbers, with *S. johnstoni* having one of the lowest diploid numbers of any African shrew. Although spreads obtained from specimens of *S. morio* from Mount Cameroon were unsuitable for the preparation of publishable karyotypes, a diploid number of 38 could be determined. Specimens of this taxon from Bioko were described as a new subspecies, *S. morio isabellae,* by Heim de Balsac (1968), but have been regarded recently as a full species by Hutterer (1993) based on morphological differences. Specimens from the Bamenda plateau of Cameroon, from which the karyotypes reported here were obtained, appear to be morphologically indistinguishable from the insular population described by Heim de Balsac (1968) and are regarded as representing the same species, *S. isabellae,* with *S. morio* confined to Mount Cameroon. The karyological differences between *S. isabellae* and *S. morio* support the recognition of the former as a full species.

The species of *Sylvisorex,* as currently understood (Jenkins, 1984; Hutterer, 1993), seem to fall into two groups. One group includes the two previously reported species with high diploid and fundamental numbers and the second the three newly reported species with low diploid and fundamental numbers. However, such a grouping is not congruent with Butler and Greenwood (1979), who placed *S. johnstoni* and *S. megalura* in one group, and *S. morio, S. ollula,* and *S. lunaris* in another based on morphological similarities. Maddalena (1990*a,* 1990*b*) also found considerable allozymic differences between *S. megalura* and *S. lunaris.* Results from these three data sets suggest that the genus *Sylvisorex* may be polyphyletic. In addition, some African species in the genus *Suncus* are very similar morphologically to species of *Sylvisorex.* Unfortunately, karyotypic data are unavailable for any of the species of *Suncus* native to Africa (e.g., *S. infinitesimus, S. lixus, S. remyi,* and *S. varilla*). *Suncus murinus* from Djibouti, from which a karyotype with a diploid number of 40 chromosomes was reported, originated from Asia or Arabia (Hutterer and Tranier, 1990).

Diploid numbers of African *Crocidura* range from 36 to 68. Within this grouping, a number of species with similar chromosomal formulae are now known (Table 1). The chromosomal formulae for *C. attila, C. greenwoodi,* and *C. olivieri bueae* (2n = 50, FN = 66) are the same as those previously reported for various subspecies of *C. olivieri* and the species *C. viaria* and *C. hirta* (review by Mad-


A
B
X Y
C
X Y

dalena and Ruedi, 1994; Table 1). However, in the case of *C. attila,* there are some notable differences in the morphology of the autosomes. These differences might reflect convergence of diploid and fundamental numbers. *Crocidura greenwoodi* is a little-known savanna shrew from Somalia. In describing it, Heim de Balsac (1966) emphasized the similarity of his new species to *C. hirta* and *C. fulvastra* (which he called *sericea*). The distinctiveness of *C. greenwoodi* from *C. hirta,* with which it shares the same karyotype, is still questionable and should be reassessed, as must be the relationship between *C. hirta* and *C. viaria.* In the case of *C. olivieri,* results from karyological studies of populations from various parts of Africa have revealed exactly the same chromosomal formula (Table 1). Although *C. olivieri* is a morphologically variable species, the homogeneity of the chromosomal formula confirms the wide distribution of this anthropophilic shrew.

*Crocidura batesi* has the same chromosomal formula as that described for *C. nigeriae* from Nigeria (Meylan and Vogel, 1982) and the two karyotypes seem initially to have a similar morphology. However, until additional data are available, especially differentially stained karyotypes, confirmation of whether this similarity is due to simple convergence or reflects close phylogenetic relationship is impossible.

*Crocidura parvipes* is in a group of species that is characterized by a diploid number of 52 (Table 1). This group includes such species as *C. lamottei, C. poensis, C. hildegardeae,* and *C. virgata.* In this case, however, the fundamental numbers and the morphology of the chromosomes are different. It will be necessary to compare the chromosomes of these species using banding techniques in order to identify the homologies and convergence between the karyotypes of the different species in this group.

The final two species of *Crocidura* examined are unique. *Crocidura picea* has a high diploid number accompanied by a large number of acrocentric chromosomes (Table 1). This condition is not known for any other species in the genus (Maddalena, 1990*a,* 1990*b*). In the case of *C. yankariensis* with a diploid number of 68 and a fundamental number of 122, the chromosomal formula is the highest yet reported for a species in the genus *Crocidura.*

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Fig. 2.—Standard karyotype of: A, *Crocidura batesi* ♀ (CM 58072), 2n = 50, FN = 76; B, *Crocidura attila* ♂ (CM 58051), 2n = 50, FN = 66; C, *Crocidura olivieri* ♂ (CM 58039), 2n = 50, FN = 66.

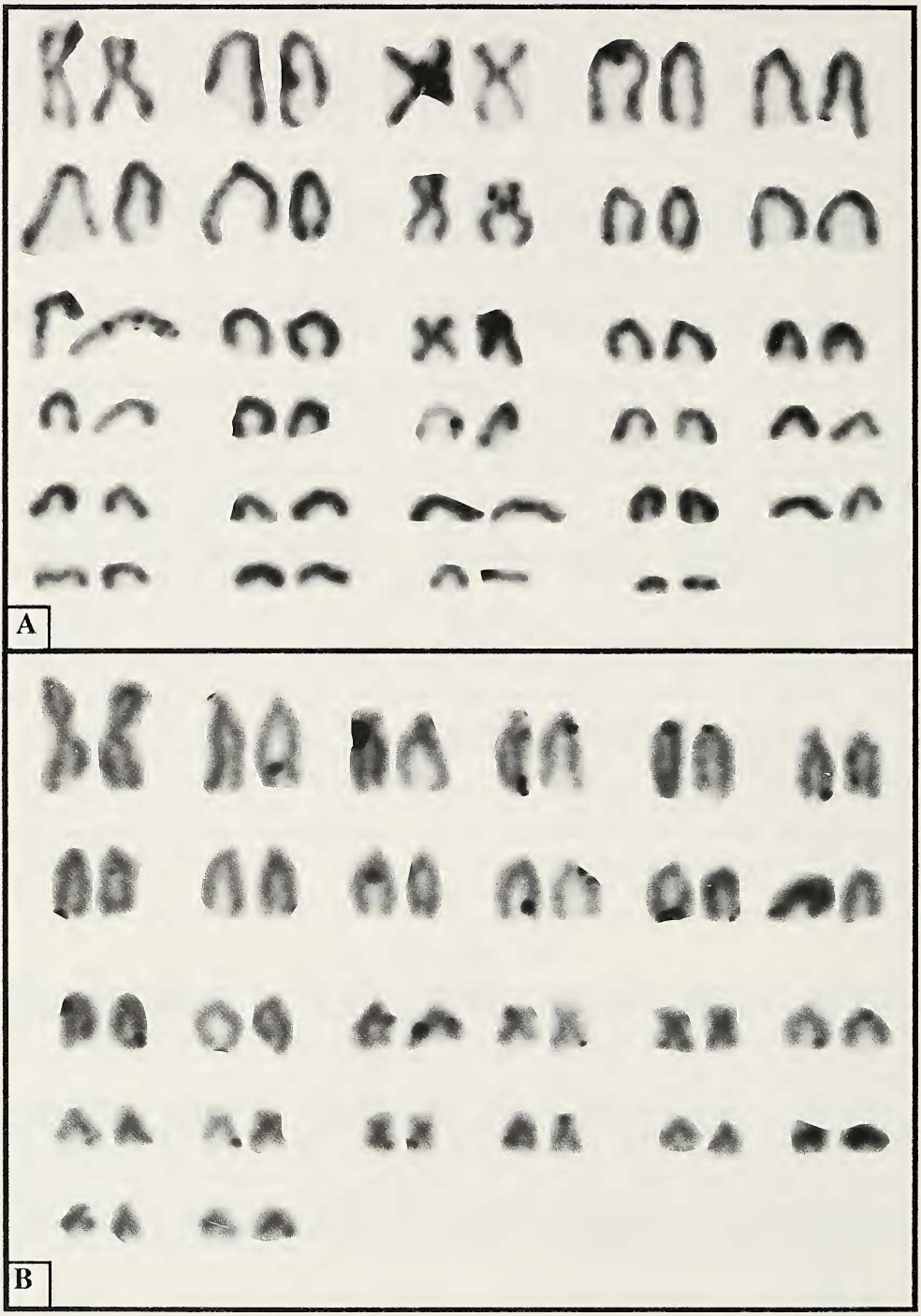


Fig. 3.—Standard karyotype of: A, *Crocidura picea* ♀ (CM 58061), 2n = 58, FN = 66; B, *Crocidura parvipes* ♀ (CM 58046), 2n = 52, FN = 66.

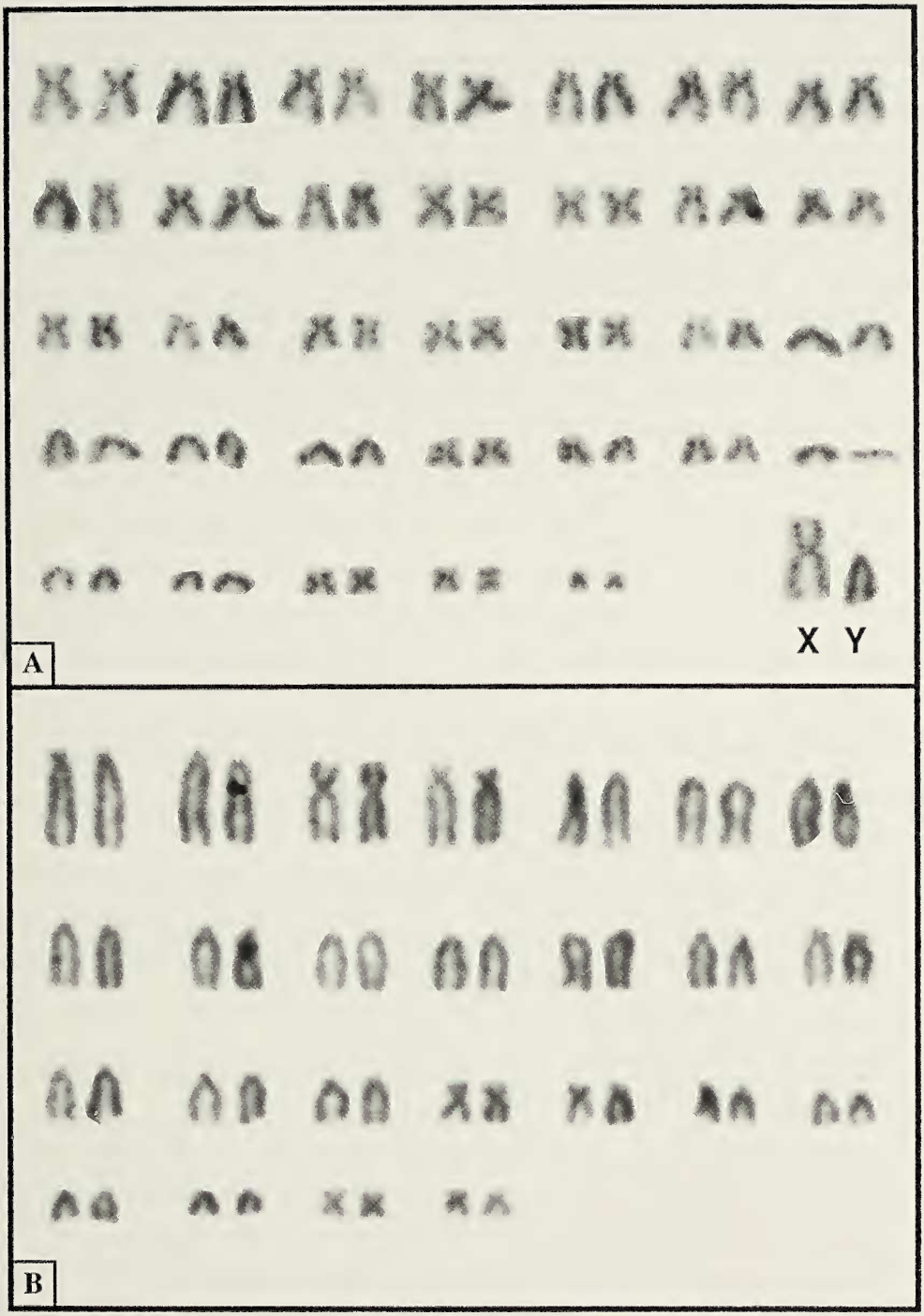


Fig. 4.—Standard karyotype of: A, *Crocidura yankariensis* ♂ (CM 85103), 2n = 68, FN = 122; B, *Crocidura greenwoodi* ♀ (CM 85088), 2n = 50, FN = 66.

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